[Name of Document]	PATENT APPLICATION
[Reference Number]	74610574
[To]	Kozo OIKAWA Commissioner, Patent Office
[International Patent Classification]	G02F 1/136
[Title of the Invention]	Active Matrix Type Liquid Crystal Display Device
[Number of Claims]	4
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[Indication of the Official Fee]	
[Prepayment Register Number]	009782
[Amount of Payment]	21,000 yen
[List of Items Submitted]	

[Name of Item]	Specification	1
[Name of Item]	Drawing	1
[Name of Item]	Abstract	1
[General Power of Attorney Number]	9715181	
[Necessity of Proof]	Necessary	

[Name of the Document] Specification

[Title of the Invention] Active Matrix Type Liquid Crystal Display Device

[Claims]

[Claim 1] An active matrix type liquid crystal display device comprising: a pair of substrates arranged so as to be opposed to each other; liquid crystal sandwiched between said substrates; a plurality of gate lines and data lines provided on one of said substrates so as to intersect with each other; a source line provided on the one of said substrates; a thin film transistor provided near an area in which said gate line and said data line intersect; a color filter and a black matrix provided for each pixel surrounded by said gate line and said data line; an overcoat layer which covers said black matrix and said color filter; a contact hole which is formed in said overcoat layer and connected to said source line; and a pixel electrode which is connected to said source line in said contact hole, wherein the position of said contact hole is biased toward a direction of an area where a disclination occurring in an area of said pixel exists.

[Claim 2] The active matrix type liquid crystal display device according to claim 1, wherein said source line under said contact hole is made of a metal film having a light shielding property, and said disclination is light-shielded by at least parts of said black matrix and said source line.

[Claim 3] The active matrix type liquid crystal display device according to claim 1, wherein a gate line of an adjacent pixel which is adjacent in a data line direction extends into said pixel so as to overlap with said black matrix to form a sticking-out portion, said sticking-out portion is made of a metal film having a light shielding property, and said disclination is light-shielded by at least parts of said black matrix and said sticking-out portion.

[Claim 4] The active matrix type liquid crystal display device according to any one of claims 1 to 3, wherein color resistor used for said color filter is photosensitive resin.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to an active matrix type liquid crystal display device, and particularly relates to an active matrix type liquid crystal display device having a CF-On TFT structure wherein switching elements such as thin film transistors (TFT) and color filters (CF) are formed on the same substrate, so as to be suitable for achieving higher precision.

[0002]

[Prior Art]

Recently, development of an active matrix type liquid crystal display device employing thin film transistors or the like as switching elements has been advanced. This liquid crystal display device comprises a TFT substrate on which switching elements such as thin film transistors or the like are formed, an opposite substrate on which an opposite electrode is formed, and liquid crystal sandwiched between the both substrates. The TFT substrate comprises thin film transistors constituted by a gate electrode, a gate insulation film, a semiconductor layer, and a source/drain electrode, pixel electrodes formed for respective pixels, a passivation film covering those above, an orientation film, and terminals for connecting to external circuits. The opposite substrate comprises a black matrix for shielding incident light coming to the thin film transistor region and wiring layers, color filters of RGB respectively for performing color display, a transparent electrode such as ITO (Indium Tin Oxide) or the like, and an orientation film, and the like. Spacers for keeping a gap between the both substrates at a predetermined distance are sandwiched therebetween.

[0003]

Higher luminance and higher precision are demanded for such an active matrix type liquid crystal display device. For these demands, it is necessary to

improve the transmissivity by increasing the area of the pixel aperture, i.e. the aperture ratio. One of the problems relevant to improving the aperture ratio is a technique for making a source/drain electrode and a pixel electrode overlap. In a case where a source/drain electrode and a pixel electrode overlap, a problem of cross talk or the like is caused due to coupling capacitance between the both electrodes, resulting in degradation of image quality. As one means for solving this, there has been known a method of keeping a distance between the source/drain electrode and the pixel electrode with the use of an interlayer insulation film comprising an organic film, thereby reducing the coupling capacitance.

[0004]

Further, in the conventional liquid crystal display device having the above-described structure wherein the color filters and the black matrix are arranged on the side of the opposite substrate, an error is caused in coordinating the positions of the both substrates in the assembly process. For this reason, it is necessary to form the color filters and the black matrix with margins taken into consideration beforehand. This makes it difficult to ensure the aperture ratio to the full, and has been an obstacle to achieving higher density.

[0005]

Hence, in order to reduce the margins for the color filters and the black matrix and improve the aperture ratio, a method of forming the color filters and the black matrix on the side of the TFT substrate on which switching elements such as thin film transistors or the like are formed, that is, a so-called CF-On TFT, has been proposed. Unexamined Japanese Patent Application KOKAI Publication No. H2-54217 and Unexamined Japanese Patent Application KOKAI Publication No. H3-237432 disclose the structure of CF-On TFT.

[0006]

A liquid crystal display device wherein the idea disclosed in Unexamined Japanese Patent Application KOKAI Publication No. H9-152625 is applied to a

substrate employing the CF-On TFT technique, will now be explained. However, it should be noted that this liquid crystal display device is not publicly known. FIG. 3 shows a plan view of an element region on an active matrix substrate in this liquid crystal display device. FIG. 4 shows a cross sectional view of FIG. 3 as sectioned along a line B-B'. A gate line 21 is formed on a transparent insulation substrate 30, and a gate insulation film 31 is formed so as to cover the gate line 21. Data lines 22 and a source line 27 are formed on the gate insulation film 31. A passivation film 32 is formed so as to cover those above entirely.

[0007]

Further, a color layer 28 is formed for each pixel. The color layer 28 is covered with an overcoat layer 29. And a contact hole 25 for connecting to the source line 27 is formed by opening the overcoat layer 29, the color layer, and the passivation film 32. A pixel electrode 24 is formed so as to cover the contact hole 25. In FIG. 3, the layer structure of the periphery of the contact hole 25 is omitted for simplification of illustration.

[0008]

In such a CF-On TFT structure, there is no need of considering the margins for positioning the TFT substrate and the opposite substrate because color filters and a black matrix are formed on the TFT substrate. This makes it possible to simplify the manufacturing process, and at the same time, achieve enlargement of the pixel aperture ratio. Further, since the contact hole 25 that penetrates the interlayer insulation film is provided on the gate line 21, the aperture ratio can be heightened.

[0009]

[Problem to be Solved by the Invention]

However, the conventional CF-On TFT structure has the problems indicated below, if it is directly employed in a liquid crystal display device suited for super high precision of a 200 dpi class.

[0010]

First, if precision is heightened further, the rate of the area of the contact hole that occupies in the pixel area is relatively increased. Further, since a hole is opened in three layers, namely the overcoat layer 29, the color layer 28, and the passivation layer 32, a margin for overlaying an exposure mask needs to be prepared. The margin portion also produces a dead space that does not allow light to transmit therethrough.

[0011]

Second, there is a problem of a light shielding area for hiding a disclination line. In a case where a pixel pitch is large enough, this problem is not so much of an obstacle. However, if the pixel pitch becomes fine, the degree of impact of decrease in the aperture ratio caused by a pattern for hiding the disclination becomes large.

[0012]

Thus, there occurs a problem that a sufficient aperture ratio can not be obtained if the above-descried structure is directly employed in a liquid crystal display device suitable for super high precision of a 200 dpi class. An aperture ratio is a ratio of a pixel area relating to optical modulation with respect to the entire display area of the liquid crystal display panel.

[0013]

The present invention was made in view of the above problems, and an object of the present invention is to provide an active matrix type liquid crystal display device having a CF-On TFT structure, that is suitable for heightening precision and can hide disclination without reducing light transmissivity.

[0014]

[Means for Solving the Problem]

The active matrix type liquid crystal display device according to the invention of claim 1 is an active matrix type liquid crystal display device comprising: a pair of substrates arranged so as to be opposed to each other; liquid crystal

sandwiched between the substrates; a plurality of gate lines and data lines provided on one of the substrates so as to intersect with each other; a source line provided on the one of the substrates; a thin film transistor provided near an area in which the gate line and the data line intersect; a color filter and a black matrix provided for each pixel surrounded by the gate line and the data line; an overcoat layer which covers the black matrix and the color filter; a contact hole which is formed in the overcoat layer and connected to the source line; and a pixel electrode which is connected to the source line in the contact hole, wherein the position of the contact hole is biased toward a direction of an area where a disclination occurring in an area of the pixel exists (or, the position of the contact hole overlaps with the area where the disclination exists at at least a part thereof).

[0015]

The active matrix type liquid crystal display device according to claim 2 is characterized in that the source line under the contact hole is made of a metal film having a light shielding property, and the disclination is light-shielded by at least parts of the black matrix and the source line.

[0016]

Further, the active matrix type liquid crystal display device according to claim 3 is characterized in that a gate line of an adjacent pixel which is adjacent in a data line direction extends into the pixel so as to overlap with the black matrix to form a sticking-out portion, the sticking-out portion is made of a metal film having a light shielding property, and the disclination is light-shielded by at least parts of the black matrix and the sticking-out portion.

[0017]

Color resistor used for the color filter may be made of photosensitive resin.

[0018]

According to the present invention, since a contact hole, a source line made of a light shielding metal film provided near the contact hole, and a black matrix

overlap a disclination area, the disclination is covered and hidden by these layers. Due to this, decrease of the aperture ratio can be prevented as much as possible, and degradation of contrast and perception of afterimage caused by the disclination's invading the display unit can be prevented. Therefore, according to the present invention, an active matrix type liquid crystal display device having high contrast and no afterimage can be achieved.

[0019]

A disclination is a line or dots along which the orientation direction of liquid crystal molecules in the liquid crystal layer becomes discontinuous, and is caused by distribution of an electric field by an abrupt drive voltage.

[0020]

[Embodiments of the Invention]

An embodiment of the present invention will now be specifically explained. FIG. 1 is a plan view showing one pixel extracted from an active matrix type liquid crystal display device according to an embodiment of the present invention. FIG. 2 is a cross sectional view of FIG. 1 when it is sectioned along a line A-A'. FIG. 5 is for clarifying the feature of the present invention, and is a plan view showing one pixel extracted from a liquid crystal display device wherein the idea disclosed by Unexamined Japanese Patent Application KOKAI Publication No. H9-152625 is directly applied to a substrate employing the CF-On TFT technique.

[0021]

Before the embodiment of the present invention is explained, the problem of the liquid crystal display device shown in FIG. 5 will be explained. As described above, if precision is heightened, the area of a contact hole becomes relatively large in the pixel area. Hence, the present inventor studied the relationship between a pixel pitch and contribution of the contact hole area to the aperture ratio. Note that it is assumed that the contact hole has a square cross section, the size of the contact hole is not dependent on the size of a pixel

but is fixed at 8 μm (one side) × 8 μm, and an area necessary for the contact hole is 196 μm^2 on the assumption that the margins allowed for overlaying the overcoat layer and the color layer are 1.5 μm from both sides of the respective layers. If it is assumed that a contact hole area ratio refers to the area occupied by the contact hole in the pixel area, this ratio is derived as indicated in the table 1 below.

[0022]

[Table 1]

Pixel Pitch μm	Precision dpi	Contact Hole Area Ratio %
300	84.7	0.65
250	101.6	0.98
200	127.0	1.47
150	169.3	2.61
126	201.6	3.70
100	254.0	5.88
85	298.8	8.13

[0023]

In case of a pixel pitch that only allows a precision of lower than 100 dpi, it is possible to form a contact hole in a manner that the contact hole does not influence the substantial aperture ratio, by overlaying the position of the contact hole on the gate line or the data line. However, in case of a precision over 150 dpi, even if a contact hole is to be overlaid on a wiring, the contact hole can not be completely hidden in the storage pattern because the gate line or the data line is also formed thinner in order to increase the aperture ratio.

[0024]

If a 200 dpi-class element is designed for the liquid crystal display device

shown in FIG. 5 which will be described later, 200 dpi can be realized with a pixel pitch of approximately 126 μm as indicated in Table 1. However, the contact hole occupies as much as 3.70% of a pixel, which is too large to be ignored for the calculation of the aperture ratio.

[0025]

Apart from that, there occurs a problem of the necessity for preparing a light shielding area for hiding a disclination line. If the pixel pitch is large, this does not emerge as a problem. However, if the pixel pitch becomes fine, the impact given on the aperture ratio by a pattern for hiding the disclination becomes large. In a case where a conventional element pitch is large as much as approximately 300 μm, even if a disclination occurs, a gate line or a data line has a sufficient width for hiding the disclination. Therefore, there is nothing in particular to be taken into consideration as regards the position, etc. of a contact hole in the display area.

[0026]

However, when it comes to super high precision elements whose pixel pitch is 126 μm, it is preferred that the widths of a gate line and a data line be formed as thinly as possible in order to increase the aperture ratio. As a result, there has occurred a situation that a disclination which has conventionally been hidden behind a wiring invades the display area.

[0027]

Occurrence of a disclination 33 will now be explained with reference to FIG. 5. FIG. 5 shows one element extracted from among the same type of elements that should inherently be repeated in the vertical and horizontal directions. In FIG. 5, it is assumed that the rubbing direction goes from the upper right in the drawing to the lower left, as indicated by an arrow. On this assumption, since the surface of a thin film transistor projects from other portions, application of a rubbing process is influenced by this projection and results in having weaker control on the orientation of the portion behind the

projection. As a result, a disclination is likely to occur at the downstream of the rubbing. Thus, such a position as where a disclination is likely to occur is the upper left portion in the pixel area in the illustrated example. As a result, a disclination 33 occurs in the position indicated in the drawing. In a case where the disclination 33 exists within the display area, defects such as degradation of contrast and perception of afterimage are caused. In order to prevent those, it is necessary to employ a method of hiding the disclination behind something that has a light shielding property. If the disclination is simply light-shielded, a problem of decreasing the aperture ratio occurs.

[0028]

As compared to this, the active matrix type liquid crystal display device according to the present invention is a liquid crystal display device having a CF-On TFT structure wherein a TFT substrate on which gate lines, data lines and thin film transistors (TFTs) are formed has a color filter, a black matrix to be formed as an upper layer of the TFT and data line, and pixel electrodes provided. This active matrix type liquid crystal display device is characterized in that a contact hole area, a light shielding metal film (source line) in the neighborhood of the contact hole area, and the black matrix overlap with a disclination. In other words, the position of a contact hole is biased toward a direction in which a disclination that occurs in the pixel area exists. This can increase the effective aperture ratio.

[0029]

Next, the active matrix type liquid crystal display device according to an embodiment of the present invention will be specifically explained with reference to FIG. 1 and FIG. 2. As shown in FIG. 1, in the active matrix type liquid crystal display device according to the present embodiment, gate lines 1 and data lines 2 are arranged on a transparent insulation substrate 10 (see FIG. 2) so as to be orthogonal to each other, and a thin film transistor 6 is formed so as to correspond to the intersection of these wirings. The gate line 1 is

connected to a gate electrode of the thin film transistor 6, and the thin film transistor 6 equivalent to a pixel is driven by a scanning signal input through the gate line 1 into the gate electrode. The data line 2 is connected to a drain electrode of the thin film transistor 6, and inputs a data signal to the drain electrode. A pixel electrode 4 is connected to a source electrode of the thin film transistor 6 through a source line 7. A pixel capacitor is formed by a liquid crystal layer between the pixel electrode 4 on the transparent insulation substrate 10 and an opposite electrode formed on an opposite substrate.

[0030]

A black matrix 3 shown in FIG. 1 by a broken line extends along the data line 2 while having a width broader than the data line 2, and is formed on a color layer 8 (see FIG. 2) as a color filter above the data line 2. The black matrix 3 has a first broader width portion 3a that covers a gate line 1 of pixels which are adjacent to each other in the data line direction and further overlaps with the pixel electrode 4 near this gate line 1, and a second broader width portion 3b that is adjacent to the first broader width portion 3a, has a width broader than the first broader width portion 3a, and covers the thin film transistor 6.

[0031]

A contact hole 5 is provided at a position more biased than the case shown in FIG. 5 toward the area where a disclination 13 occurring in the pixel area exists. In the present embodiment, the contact hole 5 is arranged near a gate line 1 of pixels which are adjacent to each other in the data line direction, and particularly biased toward an intersection portion at which this gate line 1 and a data line 2 intersect with each other so as to be arranged near this intersection portion.

[0032]

The source line 7 whose one end is connected to the source electrode of the thin film transistor 6 has its other end extending across the pixel area in almost parallel with the data line 2. The source line 7 overlaps in the pixel area shown

in FIG. 1 with a sticking-out portion of a gate line 1 (the upper gate line in FIG. 1) of an adjacent pixel which portion diverges from the gate line 1 of this adjacent pixel neighboring the pixel shown in FIG. 1 in the direction in which a data line 2 extends so as to extend into the pixel area shown in FIG. 1. As shown in FIG. 2, the source line 7 sandwiches a gate insulation film 11 between itself and the sticking-out portion (gate line 1) so as to form a storage capacitor therebetween for storing electrostatic capacitance.

[0033]

Further, the source line 7 near the contact hole 5 arranged near the above-described intersection portion at which the gate line 1 and the data line 2 intersect, or the sticking-out portion of the gate line 1 that diverges from the gate line 1 of the adjacent pixel neighboring the pixel shown in FIG. 1 in the data line direction so as to extend into the pixel area overlaps planarly with the black matrix layer 3, in particular, the first broader width portion 3a of the black matrix layer 3.

[0034]

If it is assumed the rubbing direction goes in the direction from the upper right to the lower left of the drawing as indicated by an arrow in FIG. 1, the disclination 13 occurs in the upper left of the element. Therefore, a light shielding metal film around the black matrix 2 and contact hole 5, and the contact hole 5 are arranged so as to be overlaid on the disclination line.

[0035]

The cross sectional structure of this portion will be explained with reference to FIG. 2. The gate electrode (gate line 1) made of a light shielding metal film is formed on the transparent insulation substrate 10, and the gate insulation film 11 is formed so as to cover the gate electrode (gate line 1). The data line 2 and the source line 7 are formed on this gate insulation film 11, and a passivation film 12 is formed so as to cover the whole of these. Further, the color layer 8 is formed for each pixel, and an overcoat layer 9 is formed so as to

further cover the color layer 8. The color resist to be used for forming the color layer 8 is, for example, light shielding resin. Then, the contact hole is formed by opening a hole in the overcoat layer 9, the color layer, and the passivation film 12 at the contact position. The pixel electrode 4 is formed on the overcoat layer 9 so as to cover the internal surface of the contact hole 5. Due to this, the pixel electrode 4 and the source line 7 are connected with each other. Further, the data line 2 and the black matrix 3 are superposed and the black matrix 3 and the gate line 1 or source line 7 are superposed, thereby forming an arrangement for shielding backlight from the lower portion.

[0036]

Speaking from the aspect of aperture ratio, it is obvious that the aperture ratio is increased by an area required for the contact hole 5, by having the area for the contact hole 5 and an area necessary for hiding the line of the disclination 13 in common.

[0037]

In a case where an element is designed on the conditions that the pixel pitch is 126 μm, the area of the contact hole is 8 μm × 8 μm, and the overlaying margin for each layer is 1.5 μm, a difference in the aperture ratio of 5.5% is produced between a case of utilizing this superposing effect (FIG. 1) and a case of not utilizing this superposing effect (FIG. 5). That is, according to the present embodiment, it is possible to improve the aperture ratio by 5.5% higher than conventionally achieved. Since the aperture ratio of the element is approximately 4.0%, there is produced a relative difference of as much as 13.8%.

[0038]

A preferred embodiment of the present invention has been explained so far. However, the present invention is not limited to the present embodiment, but is open to modification and addition within the scope of the meaning of the present invention. For example, the source wiring portion (source line 7) exists

under the contact hole 5 in FIGS. 1 and 2. However, the contact hole 5 may be provided at a portion where a part of the gate line 1 and a part of the source line 7 are opposed to each other forming capacitance between the gate line 1 and the source line 7. Further, the passivation film 12 exists over the data line 2. However, the same effect can be achieved without the passivation film 12.

[0039]

[Effects of the Invention]

As explained above, according to the active matrix type liquid crystal display device of the present invention, by taking the structure in which the contact hole portion, its neighboring light shielding metal film, and the black matrix overlap with the disclination, it is possible to cover the disclination and hide it behind the contact hole portion, its neighboring light shielding metal film and the black matrix. Degradation of contrast and perception of afterimage that are caused in a case where a disclination exists in the display area as the trend for higher precision advances, can be prevented. Further, a liquid crystal display panel having high image quality can be obtained, and a panel whose aperture ratio is high can be realized.

[Brief Description of the Drawings]

[FIG. 1]

FIG. 1 is a plan view showing one pixel of a liquid crystal display device according to a first embodiment of the present invention.

[FIG. 2]

FIG. 2 is a cross section along a line A-A' of FIG. 1.

[FIG. 3]

FIG. 3 is a plan view showing one pixel of a conventional liquid crystal display device.

[FIG. 4]

FIG. 4 is a cross section along a ling B-B' of FIG. 3.

[FIG. 5]

FIG. 5 is a plan view showing relationship between a disclination and a contact hole in a liquid crystal display device.

[Explanation of Reference Numerals]

1, 21: gate line

2, 22: data line

3, 23: black matrix

4, 24: pixel electrode

5, 25: contact hole

6, 26: thin film transistor

7, 27: source line

8, 28: color layer

9, 29: overcoat layer

10, 30: transparent insulation substrate

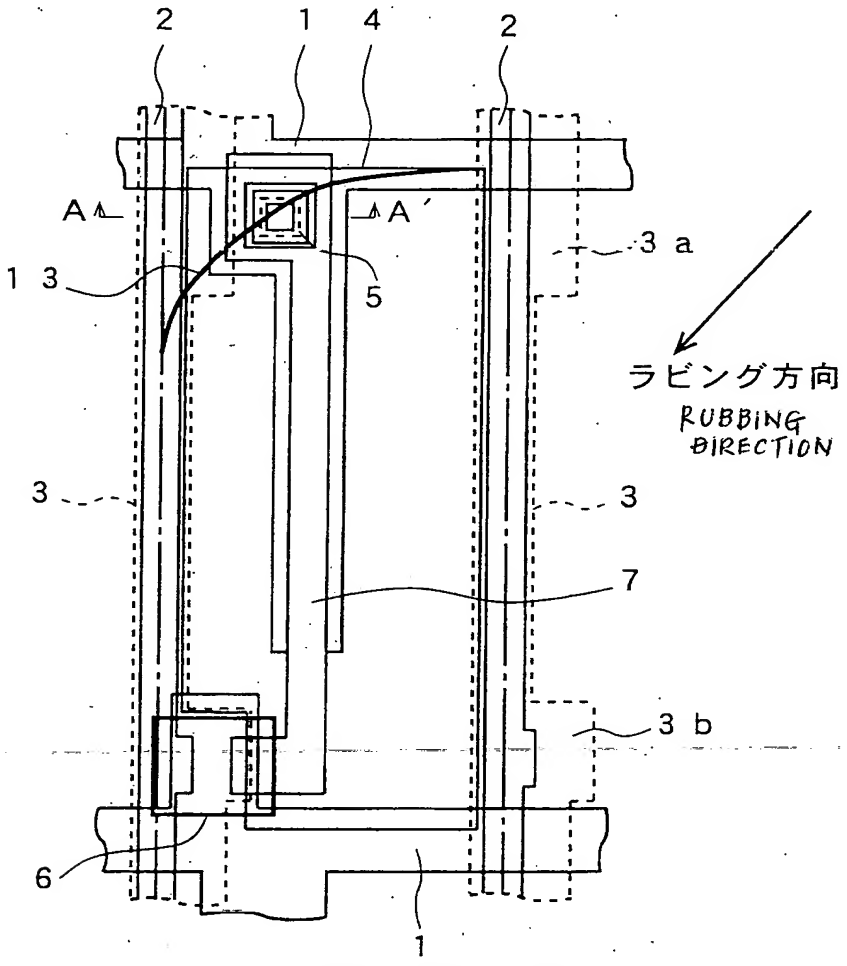
11, 31: gate insulation film

12, 32: passivation film

13, 33: disclination

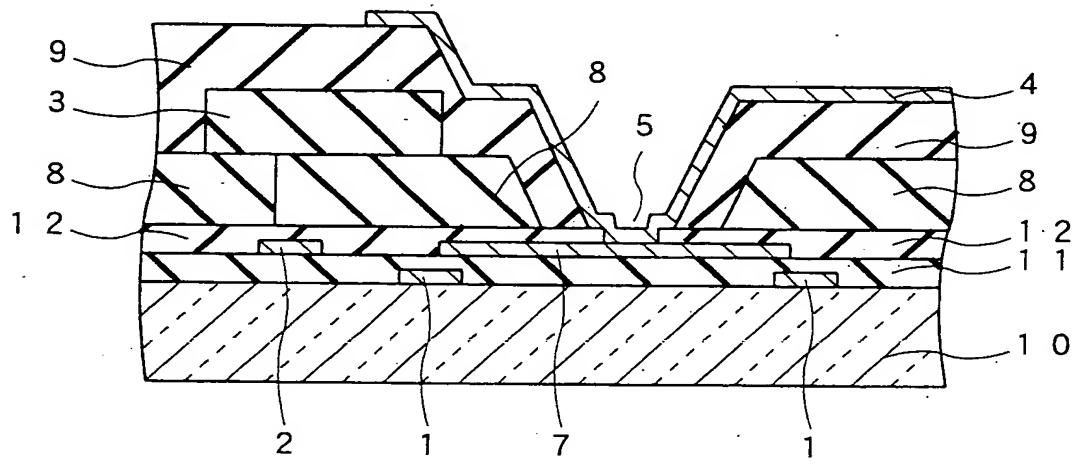
【書類名】　図面
[NAME OF DOCUMENT]　DRAWING

【図１】
[FIG. 1]



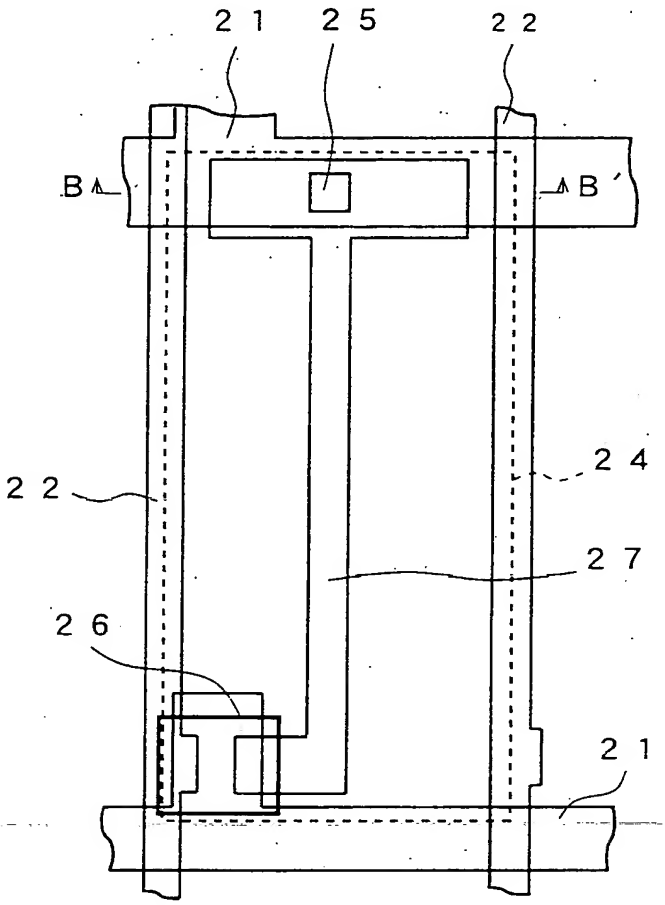
１：ゲート線　GATE LINE
２：データ線　DATA LINE
３：ブラックマトリクス　BLACK MATRIX
４：画素電極　PIXEL ELECTRODE
５：コンタクトホール　CONTACT HOLE
６：薄膜トランジスタ　THIN FILM TRANSISTOR
７：ソース線　SOURCE LINE
８：色層　COLOR LAYER
１３：ディスクリネーション　DISCLINATION

【図２】
[FIG.2]



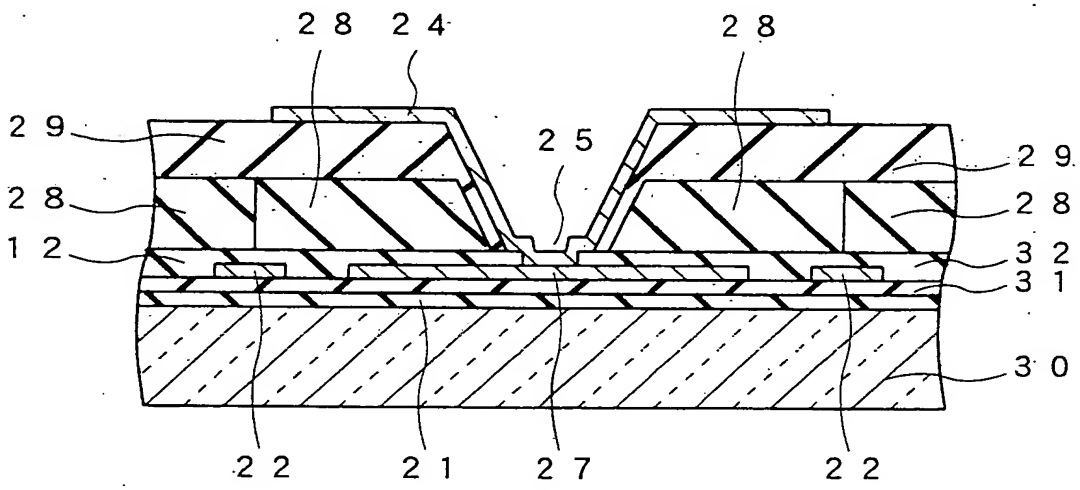
１：ゲート線　GATE LINE
２：データ線　DATA LINE
３：ブラックマトリクス　BLACK MATRIX
４：画素電極　PIXEL ELECTRODE
５：コンタクトホール　CONTACT HOLE
６：薄膜トランジスタ　THIN FILM TRANSISTOR
７：ソース線　SOURCE LINE
８：色層　COLOR LAYER
９：オーバーコート層　OVERCOAT LAYER
１０：透明絶縁基板　TRANSPARENT INSULATION SUBSTRATE
１１：ゲート絶縁膜　GATE INSULATION FILM
１２：パッシベーション膜　PASSIVATION FILM

【図３】
〔FIG.3〕



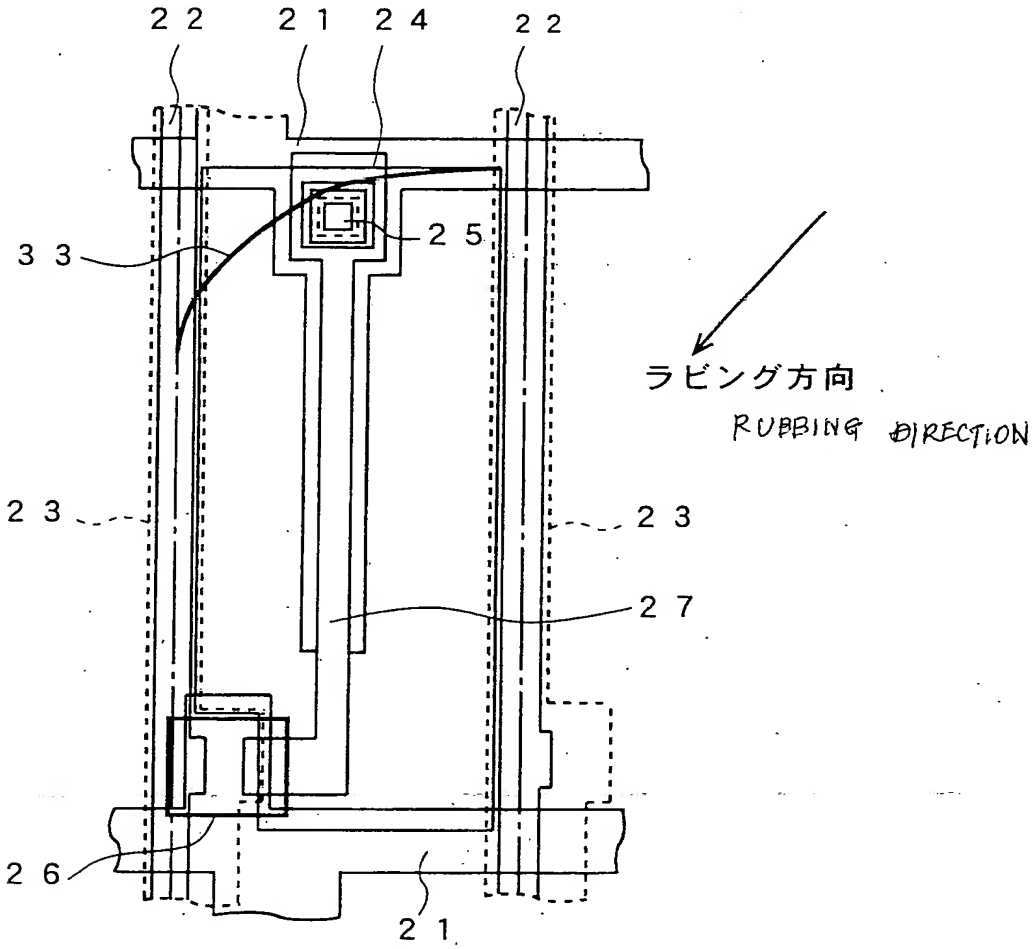
２１：ゲート線　GATE LINE
２２：データ線　DATA LINE
２４：画素電極　PIXEL ELECTRODE
２５：コンタクトホール　CONTACT HOLE
２６：薄膜トランジスタ　THIN FILM TRANSISTOR
２７：ソース線　SOURCE LINE

【図４】
[FIG.4]



２１：ゲート線　GATE LINE
２２：データ線　DATA LINE
２３：ブラックマトリクス　BLACK MATRIX
２４：画素電極　PIXEL ELECTRODE
２５：コンタクトホール　CONTACT HOLE
２６：薄膜トランジスタ　THIN FILM TRANSISTOR
２７：ソース線　SOURCE LINE
２８：色層　COLOR LAYER
２９：オーバーコート層　OVERCOAT LAYER
３０：透明絶縁基板　TRANSPARENT INSULATION FILM
３１：ゲート絶縁膜　GATE INSULATION FILM
３２：パッシベーション膜　PASSIVATION FILM

【図５】
〔FIG.5〕



２１：ゲート線　GATE LINE
２２：データ線　DATA LINE
２３：ブラックマトリクス　BLACK MATRIX
２４：画素電極　PIXEL ELECTRODE
２５：コンタクトホール　CONTACT HOLE
２６：薄膜トランジスタ　THIN FILM TRANSISTOR
２７：ソース線　SOURCE LINE
２８：色層　COLOR LAYER
３３：ディスクリネーション　DISCLINATION

[Name of Document] Abstract

[Abstract]

[Object] To provide an active matrix type liquid crystal display device having a CF-On TFT structure, that is suitable for heightening precision and can hide disclination without reducing transmissivity.

[Solution] The active matrix type liquid crystal display device comprises a plurality of gate lines 1 and data lines 2 which intersect with each other, a thin film transistor 6 provided near an area at which the gate line 1 and the data line 2 intersect, a color filter 28 provided for each pixel surrounded by the gate line 1 and the data line 2, a black matrix 3, an overcoat layer 9 which covers the black matrix 3 and the color filter 28, and a pixel electrode 4. The position of a contact hole 5 connected to a source line 7 is biased to the direction of an area in which a disclination 13 occurring in the pixel area exists.

[Selected Drawing] FIG. 1